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2. Patent application number *(The Patent Office will fill in this part)*	11 SEP 2003	0321286.7
3. Full name, address and postcode of the or of each applicant *(underline all surnames)*	Safeglass (Europe) Limited Whitworth Building Scottish Enterprise Technology Park East Kilbride GLASGOW G75 0QD	
08712010001 Patents ADP number *(if you know it)*		
If the applicant is a corporate body, give the country/state of its incorporation	UK	
4. Title of the invention	Improved container	
5. Name of your agent *(if you have one)* "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Kennedys Patent Agency Limited Floor 5, Queens House 29 St Vincent Place Glasgow G1 2DT	
Patents ADP number *(if you know it)*	0805 824 0002	

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8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *See note (d))*	Yes

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Description	14
Claim *(s)*	
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11. I/We request the grant of a patent on the basis of this application.

Signature KENNEDYS Date 11 September 2003

12. Name and daytime telephone number of person to contact in the United Kingdom Karen Veitch Tel: 0141 226 6826

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Improved Container

The present invention relates to a container for foodstuffs and beverages which has improved safety characteristics when compared to conventional containers.

Traditionally, the containers in which alcoholic drinks, carbonated soft drinks and oxygen sensitive juices are sold are manufactured from glass. Glass bottles are well received by consumers as they impart the impression of a high quality product and have "chink factor". Nevertheless, the use of bottles is inherently dangerous, as glass is easily broken. It will be appreciated that this is a particular problem in bars, pubs and nightclubs, where accidental breakage of glass bottles, is a potential health risk.

Glass bottles are also disliked as they can be used deliberately, as weapons, to inflict damage on other persons. In fact, safety regulators have actively encouraged drinks manufacturers, as well as establishments which serve drinks and alcohol, to use bottles and glasses made from non-dangerous materials, in

order to reduce the number of serious injuries caused by glass and bottle attacks.

In recent years there has been a move towards providing bottles manufactured from materials which are not as dangerous as glass. It is estimated that packaged beer production world wide in 1996 was 106.6 billion litres, requiring 186.2 billion bottles and 73.7 billion cans. The beer bottle marker was forecasted to grow at an annual rate of three percent through 2001 to 216 billion units. Most bottle production makes use of glass with only 0.1 billion plastic bottles being utilised in 1996. However due to the push towards increased safety it is estimated that the demand for plastic bottles is forecast to reach 2.5 billion by 2006.

The focus on safer bottles is particularly important with respect to alcoholic drinks, which are consumed in bars and nightclubs. PET, poly(ethylene terephthalate), a plastic which can be readily manufactured into bottles, and which does not break as readily as glass, has already been used for this purpose.

However the use of PET poses its own problems to the industry. PET is a relatively expensive material and not cheap to processwhich makes it a less popular option for drinks manufacturers. In addition, there is a general consensus that plastic bottles are not as well received by the public as they feel cheaper and do not have the same high quality feel as glass.

It is an object of the present invention to overcome the problems that are described above with reference to glass and existing plastic bottles.

According to a first aspect of the present invention, there is provided a container manufactured from a material that shatters when broken into fragments which do not cut, puncture or otherwise damage human skin or tissue.

The container may be a bottle, glass, tumbler, or the like.

Preferably the material is comprised of an amorphous thermoplastic polymer and one or more low molecular weight resins.

Preferably the amorphous thermoplastic polymer is chosen from the group consisting of:

- polystyrene (PS)
- styrene-acrylonitrile co-polymer (SAN)
- linear polyesters and co-polyesters
- polycarbonate (PC)

Preferably the one or more low molecular weight resins are hydrocarbon resins.

Preferably the one or more low molecular weight resins are aromatic hydrocarbon resins

The one or more low molecular weight resins chosen will be completely compatible with the chosen polymer. For

example, in the case of polystyrene, the low molecular weight resin will typically be C9 aromatic hydrocarbon resin.

Preferably the material has a tensile stress limit between 11 and 60 Nmm^{-2}.

Preferably the one or more low molecular weight hydrocarbon resins are selected from a group consisting of:

- Norsolene™
- Krystalex™
- Plastolyn™
- Endex™
- Piccotex™
- Piccolastic™
- Sukorez™
- Arkon™

Most preferably the one or more low molecular weight hydrocarbon resins are selected from a group consisting of; Norsolene W90™, Norsolene W100™, Norsolene W110™, Kristalex F85 ™, Kristalex F100 ™, Kristalex F115 ™, Plastolyn 240 ™, Plastolyn 290 ™, Endex 155 ™, Piccolastic D125 ™, Sukorez 100 ™, Sukorez 120 ™, Arkon P100 ™, Arkon P125 ™, Arkon P140 ™, Piccotex 75 ™, Piccotex 100 ™ or Piccotex 120 ™.

Preferably the low molecular weight resin will have a $\overline{M_n}$ (number average molecular weight) such that it has

less than 500 repeating units, and preferably less than 50 repeating units.

The container may be manufactured from the material using injection blow moulding and/or injection stretch blow moulding techniques.

Alternatively, the container may be manufactured from the material using extrusion blow moulding.

Optionally the material of the container may also comprise a oxygen barrier. The material of the container may also comprise oxygen scavengers.

The barrier included in the material of the container may be selected from the group consisting of: acrylonitrile-methyl acrylate copolymer, ethylene vinyl alcohol (EVOH) or nylon MXD6.

Preferably the barrier is Barex ™. Most preferably the barrier is Barex™ 210 or Barex™ 218.

In the embodiment where nylon MXD6 is used as a barrier, the oxygen scavenger may be X-312. Amosorb 3000, or a scavenger of MXD6 with metal catalysed oxygen reduction chemistry may also be used.

The barrier may be overmoulded or sprayed onto the container or alternatively may be included in the material of the container, using co-injection techniques.

The container may also have an inorganic coating. This may be a thin layer of amorphous carbon. The inorganic

coating may be applied to the inside surface of the container. Typically the inorganic coating will be applied in a layer of 100 to 200nm thickness. The layer may be applied by spraying.

The container may also have an external organic coating. The external organic coating may be PVDC or a two component epoxyamine.

The container may be manufactured from multiple layers of the material. Two or more layers of the container may be combined to act as an improved oxygen barrier.

Optionally the material of the container may also include UV inhibitors, antioxidants, flow modifiers, colour pigments and brighteners as known in the art.

Preferably as the amorphous thermoplastic polymer is mixed with the one or more low molecular weight hydrocarbons, the glass transition temperature is elevated. Preferably the material of the container has a glass transition temperature of above 80°C.

Potential uses of the container are not limited. For example, the container may be used for beer, carbonated soft drinks, oxygen sensitive juices, beverages or milk

A container having improved safety characteristics is manufactured from a material comprised of an amorphous thermoplastic polymer and one or more resins. The resins are aromatic hydrocarbon resins and are selected from a group consisting of Norsolene ™, Krystalex ™, Plastolyn ™, Endex ™, Sokorez ™, Arkon ™, Piccolastic™ and

Piccotex™, and in particular Norsolene W90™, Norsolene W100™, Norsolene W110™, Kristalex F85 ™, Kristalex F100 ™, Kristalex F115 ™, Plastolyn 240 ™, Plastolyn 290 ™, Endex 155 ™, Piccolastic D125 ™, Sukorez 100 ™, Sukorez 120 ™, Arkon P100 ™, Arkon P125 ™, Arkon P140 ™, Piccotex 75 ™, Piccotex 100 ™ or Piccotex 120 ™. In a particular embodiment the one or more low molecular weight resins are C9 hydrocarbon resins. The one or more low molecular weight resins have an $\overline{M_n}$ (number average molecular weight) such that it has less than 500 repeating units. In one particular envisaged embodiment the one or more low molecular weight resins have less than 50 repeating units. The resin or resins chosen will be selected on compatibility with the chosen polymer.

Low molecular weight in resins is a function of the length of the chains in the resin. In this case the hydrocarbon resins have a very low molecular weight, too low in fact for the resins to be of any use as a structural plastics material on their own, and are difficult to mould. By mixing low molecular weight hydrocarbon resin with polystyrene, the stress limit of the polystyrene is reduced giving the material the characteristics described in the present Application.

The amorphous thermoplastic polymer is chosen from the group consisting of polystyrene (PS, styrene-acrylonitrile co-polymer (SAN), linear polyesters and co-polyesters and polycarbonate (PC). These can be mixed, blended or polymerised with the one or more low molecular weight resins. UV inhibitors, dyes, antioxidants, flow modifiers, colour pigments and brighteners can also be added to change or adapt the appearance of the container.

The container herein described has many characteristics similar to an ordinary glass bottle - i.e. clarity, rigidity and brittleness. However when broken, the bottle shatters into fragments which are harmless and cannot be used to cut or pierce human skin.

The material used to manufacture the container is fundamentally a blend of a rigid and normally brittle amorphous thermoplastic with a glass transition temperature Tg at least 50° C above ambient and one or more compatible low molecular weight resins. A rigid and normally brittle amorphous thermoplastic polymer is blended with one or more low molecular weight resins which have a $\overline{M_n}$ (number average molecular weight) such that the resin has less than 500 repeating units, preferably less than 50 repeating units. The one or more low molecular weight resins have a weight average molecular weight of 6050 or below. The material is, by design, manufactured to break between 11 and 60 Nmm^{-2}.

The material can be heated and made into the desired shape of the container, i.e. a bottle, glass or tumbler, by any suitable technique known to the art e.g. injection moulding, extrusion blow moulding or pre-form injection blow moulding techniques.

The container may be manufactured from one or more layers of the material. More than one layer may be used to provide improved oxygen barrier characteristics. Alternatively the container may be coated with an oxygen barrier. Conventional coating technologies can be broadly divided into two categories. The first are those that

use vacuum or plasma routes to deposit very thin films of materials, such as carbon or silica, onto the surface of the article being coated. The second, rely on the atomised spraying of liquid organic materials onto the external surfaces of the bottle. Ideally all coating materials must not interfere with the economics of recycling, nor detract from the bottle's appearance, but a significant further consideration with thin film internal deposits is the need for the materials to be approved for food contact.

As the container described herein is manufactured from the material at lower processing materials than conventional plastics, barriers which are not usually suitable for this purpose can be used. For example the container can be coated in Barex™ (acrylonitrile-methyl acrylate copolymer), and in particular Barex™ 210 or Barex™ 218, which has high oxygen barrier properties. This can be achieved either by overmoulding, spraying or co-injection techniques. The barrier could alternatively be acrylonitrile-methyl acrylate copolymer, ethylene vinyl alcohol (EVOH) or nylon MXD6. The barrier could be provided on the inside or outside of the container.

Oxygen scavengers such as all polyester Amosorb 3000 or X-312 scavenger may be used. These Oxygen scavenging materials can be incorporated into the material of the container to react with the gas before it reaches the contents. Amosorb 3000 or X-312 scavenger have particular application when the barrier selected is MXD6 nylon. With these types of active oxygen scavenging packages, shelf life performance is determined solely by the rate of carbonation loss and CO_2 loss is reduced by the presence

of the MXD6 as a physical barrier. A scavenger of MXD6 with metal catalysed oxygen reduction chemistry may also be used (Oxbar). This system reacts very quickly with oxygen in the container and has a high oxygen capacity, ensuring a long active life.

The container may also have an inorganic coating such as amorphous carbon. This can be sprayed onto the surface of the container being coated. The inorganic coating can be applied either to the inside or outside of the bottle after blowing. Plasma-applied coatings, using carbon or silicon, which have recently been developed, may be used. The Sidel Actis™ and Kirin DLC™ coating technologies can be used produce a thin layer of amorphous carbon, typically 100 to 200nm thick, on the inside surface of the container. This is deposited from a high-energy plasma of acetylene gas within a high vacuum environment. The coating provides an excellent barrier to both O_2 and CO_2, and, because it is on the inside of the container, prevents the O_2 dissolved in the material of the container from migrating into the contents of the container during the first few weeks of storage.

Because the deposited layers are fundamentally brittle, they have to be extremely thin in order not to flake off under container stresses, caused by bottle expansion and creep when the bottle is filled, and under pressure from the contents. Other factors include damage and scuffing due to bottle handling, but these clearly do not affect the integrity of the coating if it is on the inside. The barrier performance improvements of carbon coatings are similar to those achieved by organic coatings, again

giving a longer potential retail shelf life of around nine months.

Silica technologies such as Glaskin and BestPet can also be used. These rely on the application of a SiO_x vacuum plasma coating, to give a barrier layer between 40 and 60nm thick. While the Glaskin process applies the glass clear coating to the inside of the bottle, the BestPet technique applies it to the outside.

As an alternative an organic coating may be used. External organic coatings have been known and used in the industry since the early 1980s. In the mid 1990s, barrier coating solutions based on two component epoxyamine chemistry (Bairocade) were developed, first to lengthen the shelf life of the smaller soft drink sizes in hotter climates, and then for beer. These provide a transparent, glossy, external spray coating which is an excellent barrier to migration of CO_2 and O_2, and is unaffected by humidity. The low temperature thermoset cure provides a tough film, robust to filling and handling conditions.

Typically the coating will be applied to the container at thicknesses between 6μm and 10μm, and allow the use of standard resins and preforms with existing injection and blow moulding equipment. The use of such coatings provides a performance improvement which is around 19 times better than an uncoated container and translates into a longer retail shelf life. The external organic coating may be PVDC two component epoxyamine.

The alternative approach to improving the gas permeation properties of the container material is to manufacture it from multiple layers of the material. In other words, two or more layers of the container may be combined to act as an improved oxygen barrier. Final shape blowing produces a bottle with up to seven different polymer layers, which either act as a physical barrier to gas permeation, or are chemically active in scavenging oxygen from the material of the container and intercepting oxygen diffusing in from outside.

The material herein described has an elevated glass transition temperature, which is much higher than the glass transition temperature of, for example, PET. PET has a glass transition temperature that is lower than the pasteurisation temperature used in the beer industry. As a result when PET is used in the manufacture of bottles, creep may occur during filling. In other words the material expands, which causes deformity of the bottle. This problem is eliminated using the material herein described as the glass transition temperature is above the pasteurisation temperature used during filling.

Furthermore, bottles made from PET are generally filled using flash pasteurisation, as opposed to full pasteurisation, which the industry prefers. Full pasteurisation is generally more efficient which results in a longer shelf life for the product. However full pasteurisation is not generally used with PET materials. A particular advantage of the material herein described is that because it has an elevated glass transition temperature, it can withstand full pasteurisation.

It has been discovered that using the above described material a container such as a bottle, glass or tumbler can be manufactured which does not cut, puncture or otherwise damage human skin or tissue when broken. In other words, the container will shatter into harmless fragments, shards or pieces when broken.

A particular advantage of the container described herein, lies in the fact that even though it does not shatter into dangerous fragment when broken, it has a similar quality feel as glass, and has improved aesthetic qualities over existing plastics such as PET. The material herein described for use in manufacturing a container, is relatively light and glass-like to touch and as it is a polymer is can be processed, for example by including oxygen barriers during production. Importantly, the material is thicker than an equivalent PET bottle so has a more glass-like feel but can be manufactured into containers without an increase in cost.

Example 1

An 85% mix of polystyrene polymer and 15% resin is used to manufacture a bottle with improved safety characteristics. The 15% resin maybe comprised of a single resin selected from the group consisting of Norsolene ™, Krystalex ™, Plastolyn ™, Endex ™, Sokorez ™, Arkon ™, Piccolastic™ and Piccotex™, or may be a combination of two or more of the above. Plastolyn ™ is particularly suitable for this purpose. The resin or resins are selected to achieve a desired molecular weight range.

Further modifications and improvements may be added without departing from the scope of the invention herein intended.